The Sawmill Creek Targeted Watershed Project

Arthur Slade Middle School students stocking fish at Tributary 9 stream restoration project

BACKGROUND

Many of Maryland's watersheds have been, or are in the process of being degraded by increased urbanization, industrialization, or agricultural practices. The cumulative effects from these practices can adversely impact the biological, chemical, and physical components of the aquatic environment making it unsuitable for living resources. To combat these problems the Governor's Bay Work Group initiated the Targeted Watershed Project. The Targeted Watershed Project was created to demonstrate that improvements in water quality and habitat conditions could be achieved by coordinating the monitoring, pollution control, and restoration programs of public and private organizations.

The Governor's Bay Work Group identified four watersheds in 1989 that were either threatened by multiple sources of degradation from urbanization, or contribute disproportionately high levels of nutrients to the Chesapeake Bay from agricultural nonpoint sources. The four targeted watersheds are:

* *Sawmill Creek in Anne Arundel County,*
* *German Branch in Queen Anne's County,*

* *Piney/Alloway Creek in Carroll County, MD and Adams County, PA, and*
* *Bird River in Baltimore County (Figure 1).*

The Sawmill Creek and Bird River Watersheds are in urbanized areas with plans for future development. The German Branch and Piney/Alloway Creek Watersheds are in predominately agricultural regions of the state. The four watersheds selected range in size from 8,000 to 30,000 acres. Watersheds of this size were selected because it was thought that it would be easier to track improvements in water quality initiated by best management practices and restoration activities.

Figure 1: Maryland's Targeted Watershed

After the four watersheds were identified, two types of interagency teams were recruited. The first group was an overall monitoring team which worked in all four watersheds. The monitoring team was comprised primarily of scientists, managers, and technical staff with experience in physical, chemical, and biological field assessment methods. The second group consisted of four implementation teams, one for each watershed. Each implementation team included planners, land managers, scientists, and regulators who were responsible for, or knowledgeable about the specific watershed.

WATERSHED ASSESSMENT

The goals of the watershed assessment were to characterize the water chemistry, habitat value, species diversity, and detect any changes that result from various restoration projects being implemented.

The project combined several methods to accomplish a comprehensive assessment of the watershed ecosystem. The initial characterization began with a desktop survey of existing literature including; readily available reports, maps, and phone interviews with local land use agencies and regional natural resource managers. This was followed by "windshield surveys" of all the accessible stream crossings during dry weather and storm conditions. The initial observations raised new questions which led to stream walks and informal field interviews with residents.

The assessment process then became more structured with the creation of a field monitoring team and a land mangers' implementation team. The comprehensive evaluation of watershed conditions and the numerous restoration projects is being continued through ongoing biological, chemical, and physical monitoring.

Land Use Evaluation

Simultaneous with the biological and physical monitoring, the Implementation Team reviewed the land use history, current operations and future direction of development in the watershed. The team took advantage of a 1986 watershed management plan that had been commissioned by Anne Arundel County. Although the 1986 plan had been initiated at the request of local citizens, it had not been implemented due to the complexity of the issues that were beyond the scope of a single level of government to resolve. The inter-agency team held a series of briefings so that each agency could provide an update on current operations and future directions. The purpose was to minimize new development impacts and resolve existing environmental problems by coordinating the various management and restoration activities.

By the end of 1992, representatives from 40 individual offices of fifteen different organizations had participated in Implementation Team activities. An important point to make is that many of the Implementation Team members participated in the routine biological monitoring as well as

conducting a variety of other special field surveys. Through this exercise, the Team specialists became much better acquainted with the physical landscape and complicated inter-relationships that were affecting the health of aquatic system.

Citizen Participation

The environmental concerns of longtime residents not only generated the 1986 county watershed plan, it was a major factor in the Bay Work Group's selection of Sawmill Creek as one of the four Targeted Watershed Projects. At the beginning of the project, the Alliance for Chesapeake Bay was contracted to coordinate and train a group of citizen volunteers who would perform basic water quality monitoring on a weekly basis, at fixed stations that were close to their homes. This data would be used to augment the less frequent grab sampling that was done by the state biologists. Management of the program shifted to Save Our Streams in later years, and the emphasis of volunteer involvement gradually shifted from monitoring for DNR to organizing watershed education, restoration, and cleanup efforts. Some of the monitors have also continued to report pollution problems to the various management agencies. The most dedicated of the original volunteers are now the leaders of the Sawmill Creek Watershed Association. Some details of their activities are listed in Implementation Section.

The results of the biological, chemical, physical, and land use assessments suggested that four categories of problems exist within the Sawmill Creek Watershed. They include:

* *Water quality - results indicate that high nutrient export was not a problem in this watershed. The studies did reveal problems with sediment and chemical contaminants. The chemical contaminant problems were linked to many sources including stormwater runoff, deicing operations at BWI Airport, and incidental leaks at various industrial facilities around the watershed. Sediment problems were primarily due to channel erosion in the several sub-basins with high percentages of impervious surfaces.*

* *Water quantity -a variety of problems with both low baseflow and high velocity stormflow conditions were identified.*

* *Habitat stability - both habitat and stream channel stability problems exist within Sawmill Creek. Highly eroded areas, sediment deposition, channelization, dredging, and fish blockages were all documented.*

* *Cumulative effects of land use changes - The Sawmill Creek Watershed continues to evolve. Large highway projects, light rail and airport expansions, and overall development have impacted the watershed. These developments have the potential to cause increased habitat, water quality and water quantity problems.*

RESTORATION STRATEGY

To combat the environmental problems identified in the Sawmill Creek Watershed the Implementation Team began designing a strategy to help rectify the environmental problems within the watershed. A report was published in 1992 entitled Restoration Strategy for Sawmill Creek. The document summarized the watershed's evolution and organized environmental issues by 3 major land use areas: Rural / Low Density Residential in the headwaters, Commercial/ Industrial in the middle of the watershed, and Commercial/High Density Residential at the downstream end of the watershed.

The report identified problems in each area, made general recommendations on corrective actions and specified which agencies needed to coordinate their future actions. The Strategy left detailed resolutions to smaller working groups, but provided a long-range outline for comprehensive environmental restoration and watershed management.

The agencies began to implement specific restoration actions incrementally as growth or maintenance activities provided opportunities. The document was called a "Strategy" because there were no new enforcement powers or funds were set aside for this watershed. The mandate was to use only existing programs and budgets to accomplish the restoration efforts.

It should be emphasized that formulation and implementation of the Restoration Strategy was not delayed until all monitoring reports were finalized. The management team began to address obvious environmental problems as soon as opportunities arose.

IMPLEMENTATION

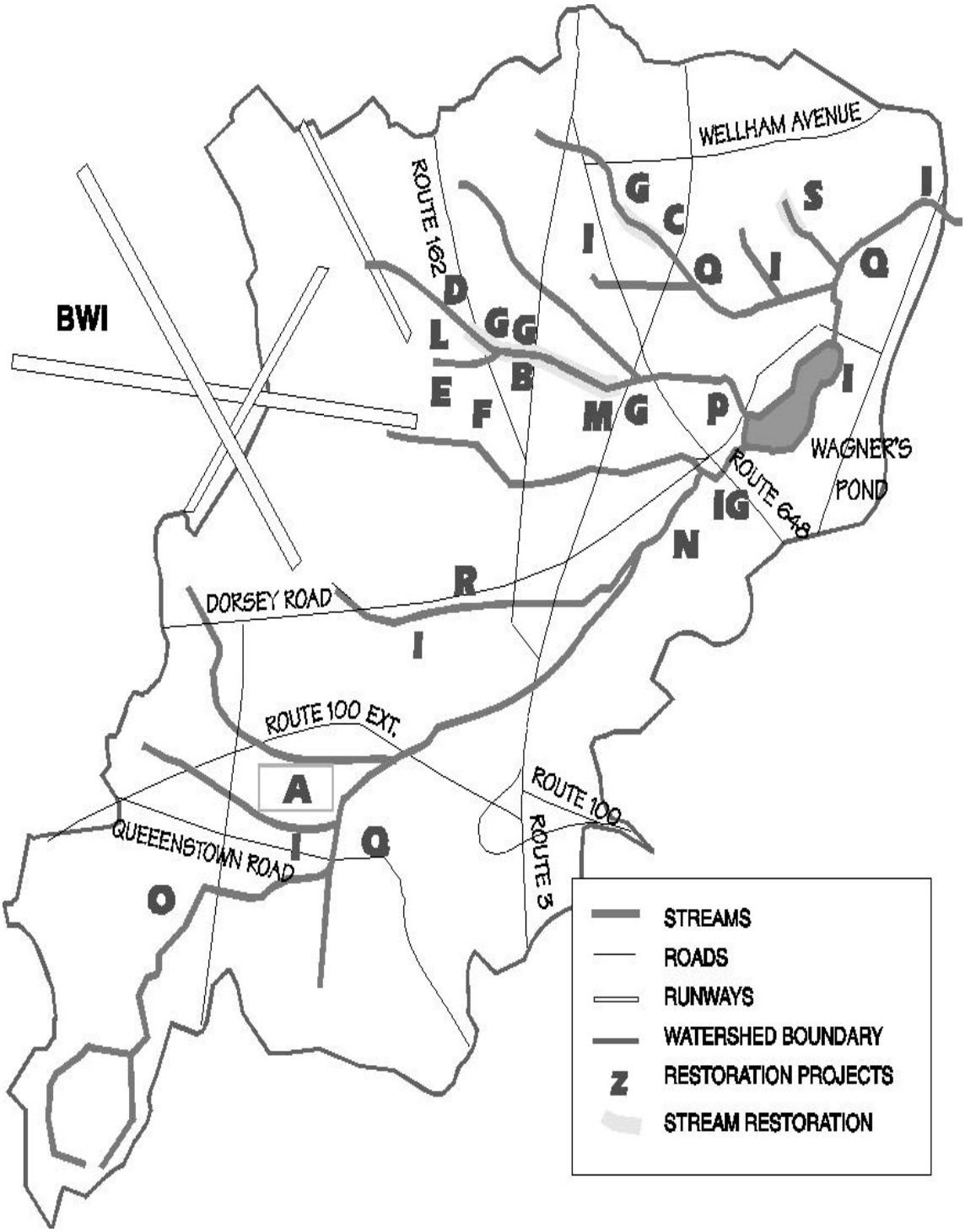
The implementation map, Figure 2**,** illustrates the distribution of a variety of environmental projects that have been designed to improve environmental conditions within the watershed. It is important to point out that these problems are not randomly or evenly distributed across the landscape. Some of them occur in clusters and all are related to local land use and localized hydro-geomorphic processes.

* *It is worth repeating that more than 90% of the implementation costs are being covered by the existing operation and maintenance budgets of the land management organizations.*

Implementation projects within the Sawmill Creek Watershed. An asterisk (*), indicates projects in the Muddy Bridge Branch sub-basin.

IMPLEMENTATION PROJECTS
A. Sand & Gravel Mine Reclamation
B. *Muddy Bridge Branch Stream Restoration
C. Tributary 9 Stream Restoration
D. *Stormwater Management Retrofits
E. *Storm water Diversions & Bioretention BMPs
F. *Wetlands Restoration & Storm water Detention Basins
G & Q. *Fish Passage Blockage Removal
I. Citizen's Monitoring & Cleanup Activities
L. *Airport chemical management
M. *Ground Water Cleanup
N. Oil Storage Facility
O. Pig Pens in Floodplain
P. *Stream channelization
R. Base flow restoration
S. Tributary 10 Stream Restoration

Figure 2. Implementation projects within the Sawmill Creek Watershed



EVALUATION OF RESULTS TO DATE:

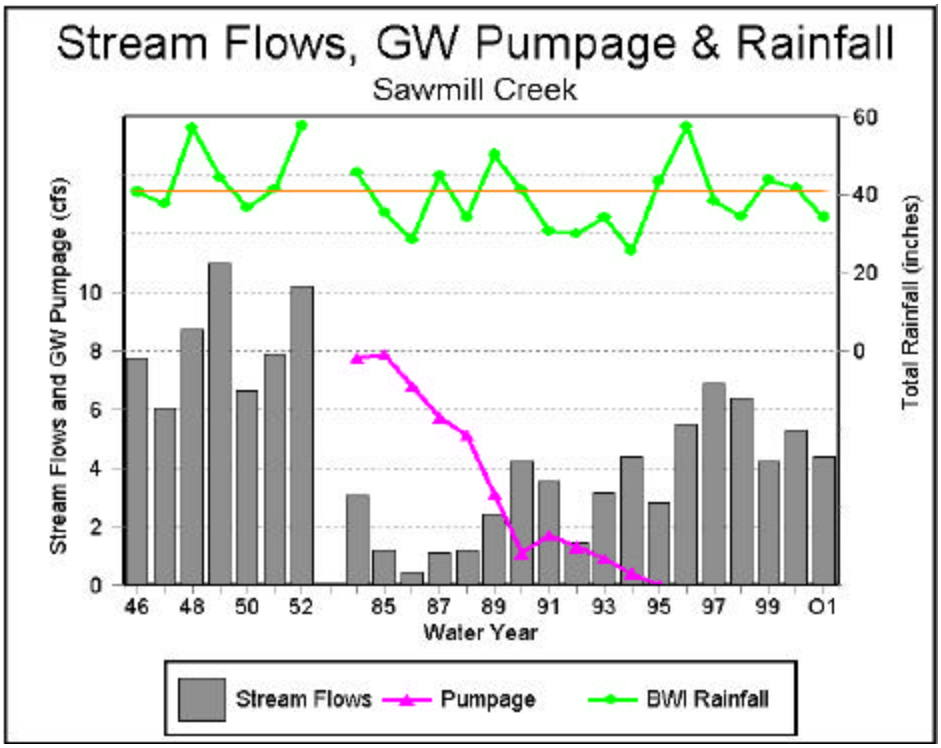
There is very little information available on the ecosystem response times for complicated watershed restoration projects. In fact, the process is so new that even the evaluation methods are still being refined. This section provides a brief description of some restoration projects shown in Figure 4. The projects on Muddy Bridge Branch are grouped together at the end of the section.

Baseflow restoration: R

The original watershed assessment described an 83% decrease in the baseflow that was caused by the cumulative effects of 45 years of gradually increasing groundwater withdrawals and impervious surfaces across the watershed. Figure 5 illustrates changes in stream flow, rainfall and groundwater pumping rates. Baseflow reductions were most severe in the mid 1980's. Pumping rates began to decline in 1980's for two reasons. The first was the gradual failure of well fields that had been drilled in the 1950's. The second was a management recommendation from the Implementation team. After considerable study it was felt that an increased investment in the county's water distribution system would be more beneficial than replacing the failing wells. By upgrading the county's pipelines the county could take advantage of surplus surface water supplies from the adjacent Baltimore City reservoir system. These actions reduced ground water withdrawals by 5.1 Million Gallons per Day (0.22 cubic meters per second), and improved operational flexibility for the county.

Although rainfall is the uncontrolled variable in this evaluation, it is apparent that stream flow has increased dramatically **(Figure 3)**. Hydro-geologists initially predicted that recovery of baseflow probably would not exceed 3 cubic feet per second (3 CFS = 0.08 cubic meters per second). It appears that the average may be closer to 4 CFS (0.11 cubic meters per day).

Figure 3. Graph of Stream Flows and Ground Water Pumpage in Sawmill Creek



Stream restoration*: *S,C,B

Three major stream restoration projects covering a total of 2467 meters have been funded in the watershed thus far. All of the projects use a natural design approach and bioengineering techniques to improve aquatic habitat and stabilize stream channels that have been impacted by erosive urban storm water runoff.

The Tributary 10 project (S) is 400 meters. The project was funded by the Chesapeake Bay Program, the Maryland Department of the Environment, the Department of Natural Resources, and Anne Arundel County. The total cost for the Tributary 10 project is $380,000. Construction was completed in March 2000.

Construction on Tributary 9 (C) was completed in 1994 at a cost of $162,582. **Table 1** compares the 335-meter Tributary 9 project before and 1 year after construction, to a reference stream in a state forest. All habitat scores are reported as percentages of a theoretically perfect stream. With the

exception of eels, this headwater area is isolated from the main stem by a fish blockage that will be removed in the fall of 2002.

A detailed botanical survey was conducted by SHA 4 years after the restoration project was completed. The results indicated significant improvements in the diversity of the riparian buffer. The original planting plan included 6 species of grass, 8 species of woody shrubs, and three tree species. In contrast the post-construction survey identified 25 species of trees and 47 species of vines and herbaceous vegetation that had volunteered in the area.

The habitat recovery rate was so rapid that the team decided to conduct a fish stocking experiment to test the habitat quality. The Sawmill Creek Savers science club of the Arthur Slade Middle School assisted in restocking small, non-game, resident fish in November 1995. Three years later, seven of the thirteen species stocked were still residing in the project area. The presence of gravid females, juvenile fish, and the piscivore Esox americana are good indications that a self sustaining fish community has been re-established in this head water tributary.

Table 1. Habitat Scores from a Reference Stream and Tributary 9 pre & post Restoration

Habitat Parameters	**Reference Scores (%)**	**Tributary 9 (Before) (%)**	**Tributary 9 (After) (%)**
Substrate & Cover	80	50	75
Embeddedness	65	25	60
Flow	60	45	30
Channel Alterations	93	13	67
Scouring and Deposition	67	40	60
Pool/Riffle/ Run Ratio	87	47	87
Bank Stability	80	30	70

Bank Vegetative Stability	90	40	90
Streamside Cover	80	60	50
Total Score	**78**	**39**	**65**
# of Fish	**9**	**1**	**7**

Citizen Activities: I

Water quality monitoring has gradually faded out and some of the original volunteers have become active in the Sawmill Creek Watershed Association. Residents, including Scout groups, and the Pascal Senior Center members have continued to participate in biannual cleanup and conservation projects. The "Sawmill Savers" from the middle school science club helped stock fish. Some residents who live adjacent to or downstream of industrially zoned areas have become activists in some specific land management issues, such as storm water management and construction permit reviews.

Activities include:

+Fish Stocking on Trib 9
+Tree plantings
+Stream cleanups
+Storm Drain Painting
+Workshops; erosion & sediment control, household toxic reduction

Fish Blockage Removals, G & Q

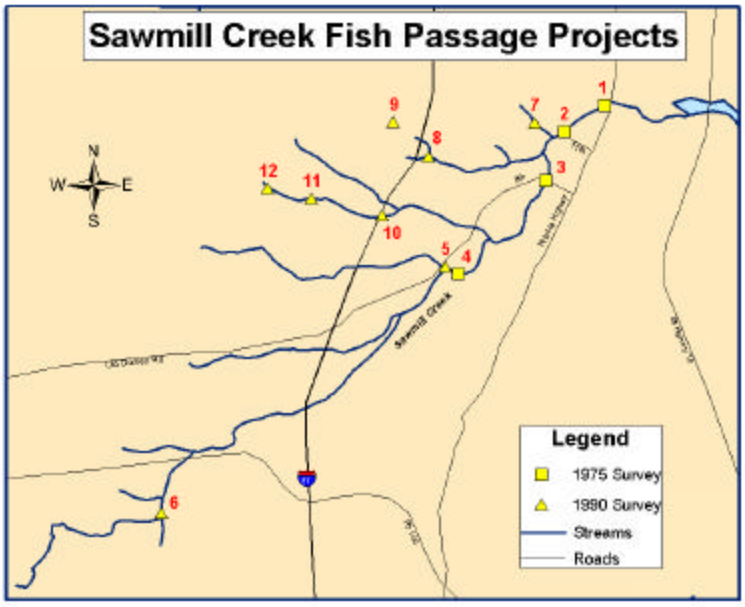


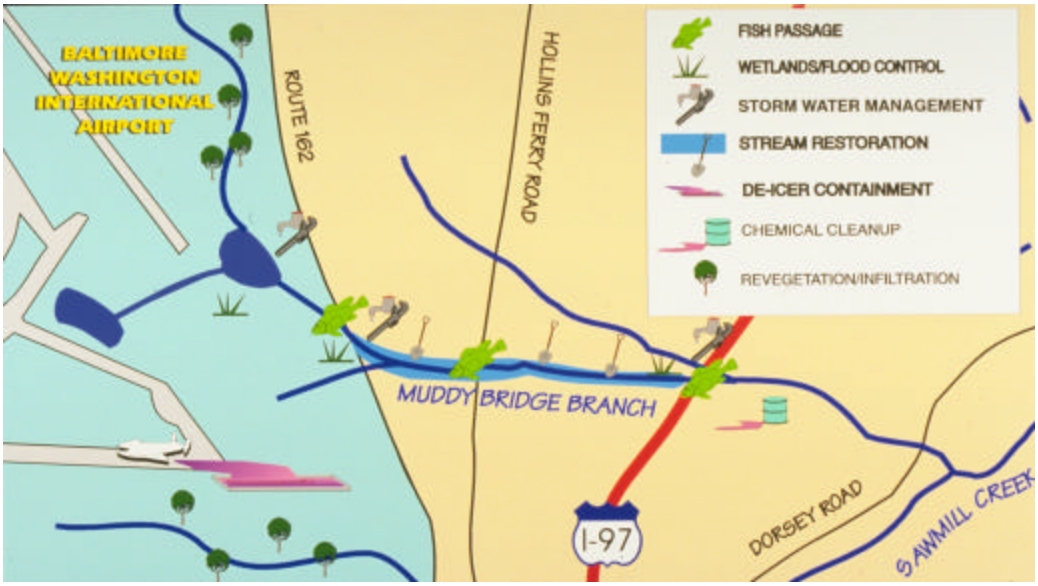
Figure 4. Fish Passage Projects

A 1975 survey of anadromous fish blockages identified four sites on Sawmill Creek. Subsequent surveys by DNR identified 8 additional blockages that restricted the movement of resident species (Figure 4). Ten of 12 blockages have been or will be corrected by the end of 2002. The State Highway Administration (SHA) and Anne Arundel County DPW corrected many of these problems as part of their routine maintenance and operations. DNR, USFW and NMFS collaborated with DPW on the design and funding of the only project that uses a conventional fish ladder design. All the rest have been accomplished using natural channel design concepts. Fish passage has been tested and directly confirmed at several locations.

MUDDY BRIDGE BRANCH PROJECT

Some problems could be dealt with on an individual basis but others needed to be managed as an integrated system. Figure 5 illustrates how the project team is applying an ecosystem management approach to deal with the most impacted sub-basin in the watershed.

Figure 5. Muddy Bridge Branch Restoration projects



Starting at the top of this sub-watershed the following projects are being implemented in order to reduce the cumulative impacts of water quantity, water chemistry and habitat problems:

Stormwater Management Retrofits, Diversions & Bioretention: D& E
Combined projects have reduced 2 year storm peaks at least 50 %. Specific elements include runoff diversions to adjacent infiltration areas, re-vegetation of drainage swales, reducing discharge pipe diameters and increasing storage capacity by raising height of a detention structure. Constructed by the Maryland Department of Transportation (MDOT) in the winter 95/96, at an estimated cost of $160,000.

Airport chemical management: *L*

There are only a hand full of airports nationwide that are trying to control the discharge of deicing chemicals to local streams. Management techniques are still under development, and have to be customized to match the weather, existing stormwater facilities and operational schedules at each location. BWI airport has invested in a mixture of structural and operational Best Management Practices (BMPs) with the short-term goal of reducing deicer discharge rates by 50%.

Laboratory tests of airport runoff have indicated that aquatic biota is still being exposed to intermittent, low level concentrations of deicing materials. It is apparent that fine-tuning of the BMPs is needed. MAA investments for deicer management facilities & operations currently exceed $24 million. Additional deicer management facilities are being incorporated into ongoing airport expansion projects.

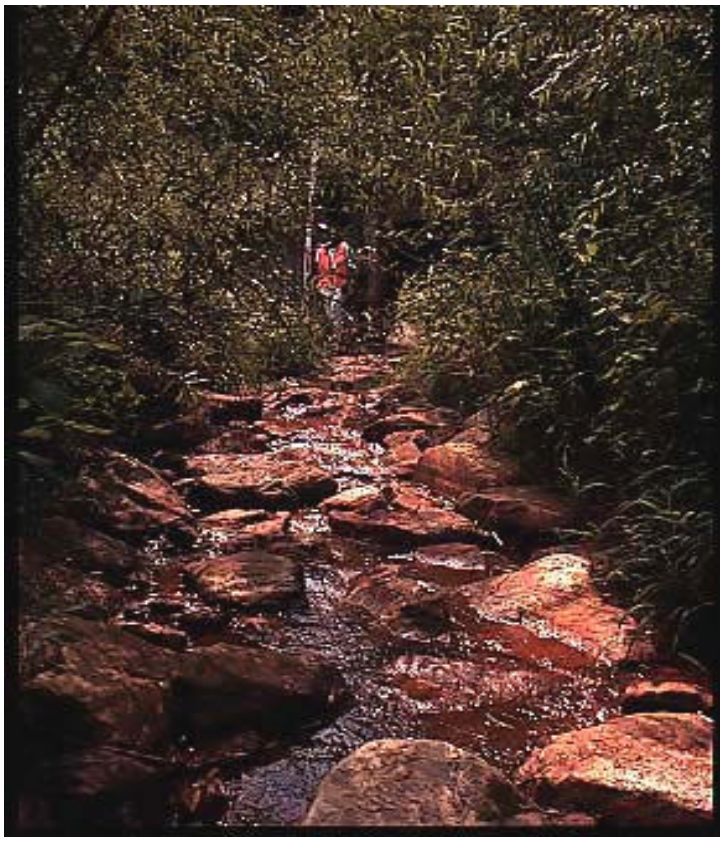
Upper Muddy Bridge Branch Stream Restoration: B

This section of Muddy Bridge Branch (MBB) was targeted for stream bank stabilization in 1992. The segment is approximately 1980 meters long with two complete fish blockages at the I 97 culvert (1.5 meter drop) and at the old Hollins Ferry road crossing (1.2 meter drop). Removal of the fish blockages was included in the stream restoration design package.

Stream restoration took place between September 1997 and January 1998. The Hollins Ferry Road crossing was removed and the culverts at the new Cromwell Blvd crossing were designed with a built-in low flow fish passage channel. A series of rock step pools had been designed to remediate the 1.5 meter vertical drop at the downstream end of the culvert. Construction of the step pools took place in several stages with the last work performed in Oct. 1999. To date, the step pools have not provided the target flow depth of 0.15 meters under base flow conditions. However resident fish have apparently been able to move up through the culvert under higher flow conditions, probably during the receding limb of storm flow events.

Muddy Bridge Branch Stream Restoration Before Construction

Muddy Bridge Branch Stream Restoration Construction



Muddy Bridge Branch Stream Restoration After Construction

Beginning in 1990, DNR sampled parts or all of Muddy Bridge Branch 12 times over a nine-year period prior to the restoration projects. It was apparent that there was no resident fish community in upper Muddy Bridge Branch because only small numbers of fish were found in plunge pools below road crossings on 4 of the 12 sampling dates. Most of the fish appeared to be either bait bucket discards or escapees from adjacent stormwater management ponds.

Post-construction fish sampling efforts were conducted one year after the step pools were installed. A qualitative, one-pass survey with a backpack electroshocker covered the entire restoration project, and a standard 75-meter quantitative survey was conducted near the middle of the project. Over 900 individual fish, (11 species) were identified in the restoration area including 3 large mouth bass.

Table 1. Muddy Bridge Branch, Pre-restoration fish surveys

Year	**90**	**92**	**93**	**93**	**94**	**94**	**95**	**95**	**96**	**96**	**97**	**98**	**90-98**
Season	**fall**	**spr**	**spr**	**fall**	**spr.**	**fall**	**spr.**	**fall**	**spr.**	**fall**	**spr**	**spr**	**Total**
Species													
Goldfish						2							**2**
Carp						1							**1**
Creek chubsucker						4							**4**
e. mud-minnow											1		**1**
Bluespotted sunfish				10									**10**
Pumpkin-seed				1									**1**
Bluegill				6		1				22	41		**70**
Total spp.	0	0	0	**3**	0	**4**	0	0	0	**1**	**2**	0	**7**
Total #				**17**		**8**				**22**	**41**		**89**

Table 2. Muddy Bridge Branch Post-restoration fish surveys

October 2000

Fish Species	**Qualitative**	**Quantitive**
	1220 meters	**75 meters**
Eel	1	2
white sucker	308	21
creek chubsucker	505	37
Mummichog	6	
e. mudminnow	15	2
Mosquitofish		1
bluespotted sunfish	1	
Pumpkinseed	15	9
Bluegill	14	
tesselated darter	62	7
large mouth bass	3	
Total individuals	**930**	**79**
Total species	**10**	**7**
Grand Total Species	**11**	

CONCLUSION

Four major categories of environmental problems were identified in the Sawmill Creek Watershed. They include water quality, water quantity, habitat stability, and cumulative effects of development. The sources of these problems are multiple. The project has made substantial efforts to identify and rectify the cumulative and synergistic impacts caused by these problems.

Studies to determine the success of the restoration projects will be ongoing for many years as the chemical, physical and biological components of the watershed adapt to man-made and climatic changes. The evolution of the intensive restoration efforts will present an excellent opportunity for future assessments by both governmental agencies and private citizen groups.

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We would like to recognize the cooperative efforts of the following organizations:

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MD Department of Transportation	MDOT
MD Aviation Administration	MAA
State Highway Administration	SHA
MD Environmental Service	MES
University of Maryland	UMD
US Fish & Wildlife Service	USFWS
US Corps of Engineers	USCOE
National Marine Fisheries Service	NMFS
Environmental Protection Agency	EPA
Save Our Streams	SOS
Alliance for Chesapeake Bay	ACB
Sawmill Creek Watershed Association	
Arthur Slade Middle School	